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IMPROVED APPARATUS AND METHOD FOR MAKING "SHELLINGS" OF ROUGH RICE

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INTRODUCTION

The commercial value of rough rice is based largely on its milling quality. Among the more important factors which denote milling quality of rough rice are degree of hardness or resistance of kernels to breakage in milling, percentage admixtures of red rice, percentage of chalky kernels, and percentage of damaged kernels present in the rice. All of these factors have an effect either upon the yield of head rice or upon the total yield of milled rice, and upon the grade of the milled rice which can be obtained from rough rice.

Rough rice varies considerably in the yield of whole kernels or head rice and in the total yield that can be obtained in milling. The greater the yield of head rice and the greater the total yield that can be made from any lot of rough rice the more will the rice be worth to the miller.

The degree of hardness of the rough-rice kernels governs this resistance to breakage in milling and is important to the miller from the standpoint of the yield of head rice that can be obtained in milling. Red-rice admixtures in rough rice are objectionable because the traces of these admixtures in the finished milled rice are not attractive and so are likely to reduce the market price of the rice. More-

over, as the red-rice kernels are usually smaller in size than are the white-rice kernels, it is necessary to set the milling machinery closer than would be necessary for white rice alone. This severe milling tends to increase breakage of the white rice and reduces the quantity of head rice that can be obtained. Both chalky kernels and damaged kernels are objectionable to consumers of milled rice, and therefore they serve to depress the price of any lot of milled rice in which they are found.

SHELLING TESTS TO ASCERTAIN VALUE OF ROUGH RICE

Because the market value of rough rice is governed to such a large extent by the factor of milling quality, it has become a practically universal custom for rough-rice buyers and graders to make "shellings" of samples prior to buying or prior to placing a valuation on the rice. In commercial practice the price that is offered for any given lot of rough rice and the selection of rough rice for milling purposes are based largely on such "shelling" tests made on representative samples of the rice involved.

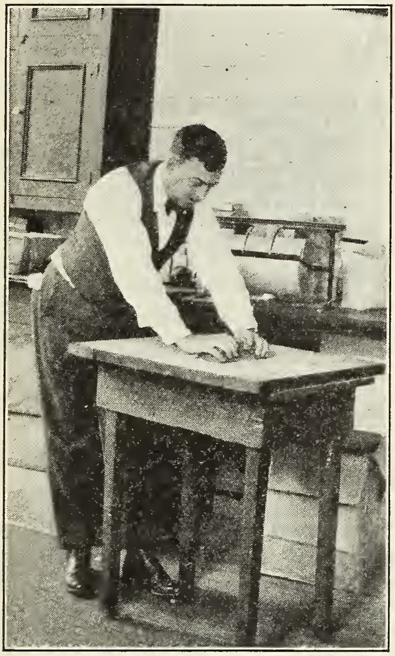

FIG. 1.—Rough-rice grader making a shelling with a corrugated wooden block

In the shelling test the hulls of the rough-rice kernels are removed so that the rice kernels are exposed to view. When accurately applied to the sample, this test makes possible a close indication of the milling value of any given lot of rough rice, particularly in so far as the factors of total yield and yield of head rice are concerned. Percentages of red rice, damaged kernels, and chalky kernels, which are difficult to determine while the hulls are still on the kernels, are easily and quickly determined after the hulls have been removed.

VARIATION IN METHODS OF MAKING SHELLINGS

Many methods are used for making shellings of samples of rough rice. In most cases the hulls are removed by placing the rice on a corrugated board and rubbing it with a small corrugated wooden block. (Fig. 1.) This method is sometimes varied by rubbing with a brick or smooth wooden block. In other cases a flat base made of a mixture of cement and emery, or of carborundum, is used and the rice is rubbed on it with a small block of the same composition or of some other substance. Often the rice is hulled by throwing it on a warehouse floor and applying pressure to it with the foot.

NEED FOR AN IMPROVED METHOD

In shellings made by any of these methods, from 5 to 15 per cent of the kernels are usually left unhulled in the sample. The kernels which are not hulled are often the ones which have a marked effect upon milling yields. This is particularly true when there are a large number of partly filled or chalky kernels in a sample. In such cases the buyer or grader is likely to make a wrong estimate of the total yield of the rice.

The particular method of making shellings and ascertaining milling quality used by each individual who makes the test no doubt serves his own purpose fairly well in most instances and there are men in the rough-rice industry who can ascertain milling quality with surprising accuracy notwithstanding the handicap of poor facilities. Occasionally, however, even the best judges of rough rice will make mistakes in their estimates of probable milling yields. This is especially true at the beginning of each season before there has been an opportunity to check estimates against milling out-turns. Moreover, it is not always possible to secure the services of a rough-rice buyer or grader who makes but few or no mistakes.

The need for a mechanical method that would decrease the chance of error always inherent in the exercise of human judgment has been increasingly evident. Uniformity of results in estimating milling yields is particularly important to any commercial rice organization that employs two or more rough-rice buyers or graders.

NEW DEVICE AND METHOD FOR MAKING SHELLINGS

Accordingly a mechanical testing device has been developed which effectively removes the hulls from samples of rough rice and indicates hardness and total yield of the rice. This device is known commercially as the Smith shelling device.[1] The device as assembled and ready for use in a rice-testing laboratory is shown in Figure 2.

The essential features of the shelling device consist of a wooden base with a downward semicircular curved surface and a rubbing block with a curved lower surface. Both the curved upper surface of the base and the curved lower surface of the rubbing block are covered with hogskin leather. The rubbing block is made of wood, and sufficient sheet lead is placed upon the block to make it weigh 15 pounds. When the machine is in operation the rubbing block is pulled back and forth over the curved surface of the base by means of chains attached to arms which, in turn, are attached to a shaft. The shaft is rotated, back and forth, by means of a handle that is actuated by an electric motor and a set of gears. A cross section of the base and rubbing block is illustrated in Figure 3.

In operation, a given quantity of the rough rice is placed in the device. The motor is started, and the rubbing block is pulled back and forth over the rice. The hulls are removed from the kernels by means of the friction on the rice kernels caused by the hogskin coverings of the inner surface of the base and the lower surface

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[1] A public-service patent (No. 1553478) covering the device has been granted to the author, who devised it. Anyone in the United States is free to manufacture or use the device without the payment of royalty.

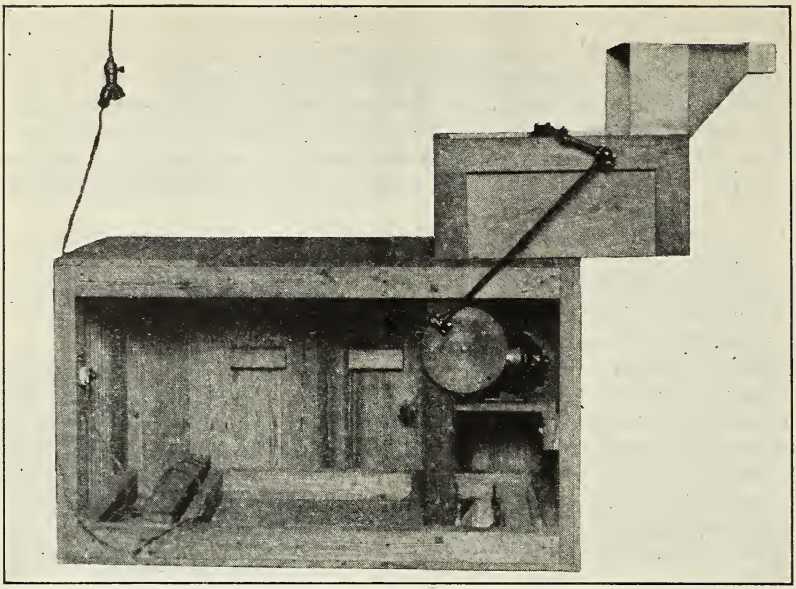

FIG. 2.—Smith shelling device ready for use

of the rubbing block. The number of times that the rubbing block rubs over the rice is governed by an automatic switch which can be set for any number of rubs desired. The switch automatically stops the rubbing action when the number of rubs for which it is set has been reached.

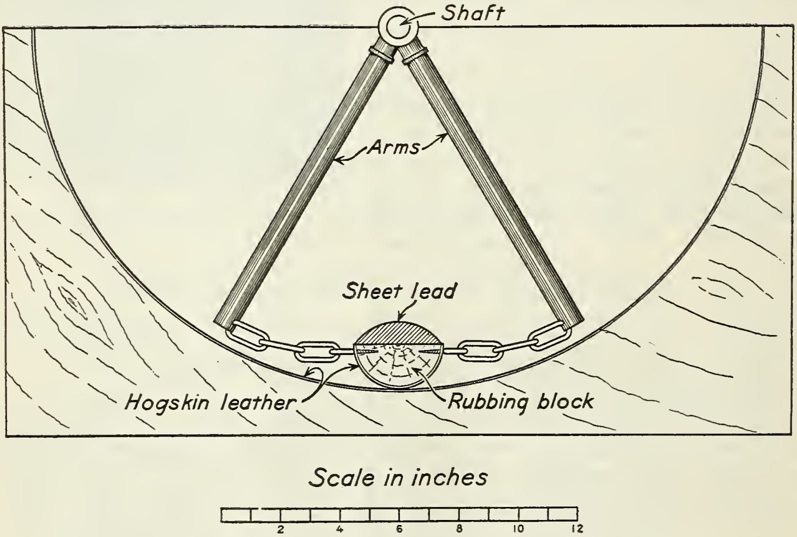

FIG. 3.—Cross section of the base of the Smith shelling device

SHELLING RESULTS OBTAINED

That the device is successful in making shellings is shown by Figure 4, which shows the comparatively large number of unhulled kernels in a shelling made by hand as contrasted with a nearly complete shelling made with the Smith shelling device.

Because of irregularities which occur in milling and because millers do not always obtain like results with rice of the same character, it is difficult to establish figures with the shelling device which will indicate definitely that certain milling yields will always be obtained by different mills from a certain lot of rice or even that any one mill will always obtain the indicated yield. This could be done in the first case only if the system of milling were exactly the same in all mills, and in the second case only if each miller could always adjust the mill machines exactly the same way each time he milled a certain type of rice. However, the shelling device makes it possible for all millers, buyers, dealers, and graders of rough rice to test the rice for milling quality in the same way. That it is possible to obtain uniform results with two shelling machines when they are propertly adjusted is shown in Table 1.

TABLE 1.—*Comparison of results obtained with two Smith shelling devices operating on duplicate portions of the same samples of rough rice*

Sample No.	Variety	Machine No.	Shelling-device results			Unhulled kernels
			Whole kernels	Broken kernels	Total rice[1]	
			Per cent	*Per cent*	*Per cent*	*Per cent*
1	Blue Rose	1	60.6	14.6	75.2	0.3
		2	60.9	14.6	75.5	.3
2	do	1	68.5	7.5	76.0	.8
		2	67.8	7.2	75.0	1.0
3	do	1	58.2	15.2	73.4	.2
		2	58.5	15.2	73.7	.3
4	do	1	68.4	8.9	77.3	.2
		2	68.3	8.8	77.1	.3
5	do	1	62.8	12.4	75.2	.2
		2	63.2	12.8	76.0	.3
6	do	1	57.8	16.4	74.2	.3
		2	57.4	17.2	74.6	.1
7	do	1	59.4	15.4	74.8	.2
		2	59.0	16.0	75.0	.1
8	do	1	64.2	9.5	73.7	1.3
		2	63.8	10.7	74.5	.8
9	Edith	1	53.6	21.0	74.6	.6
		2	53.3	21.1	74.4	.5
10	Japan	1	71.6	8.1	79.7	.0
		2	71.3	9.6	80.9	.0
11	Lady Wright	1	73.1	9.6	82.7	.0
		2	73.0	8.9	81.9	.0
12	Early Prolific	1	64.9	11.1	76.0	1.2
		2	64.3	11.1	75.4	1.9

[1] The difference between the total percentage and 100 represents the loss of hulls and other refuse.

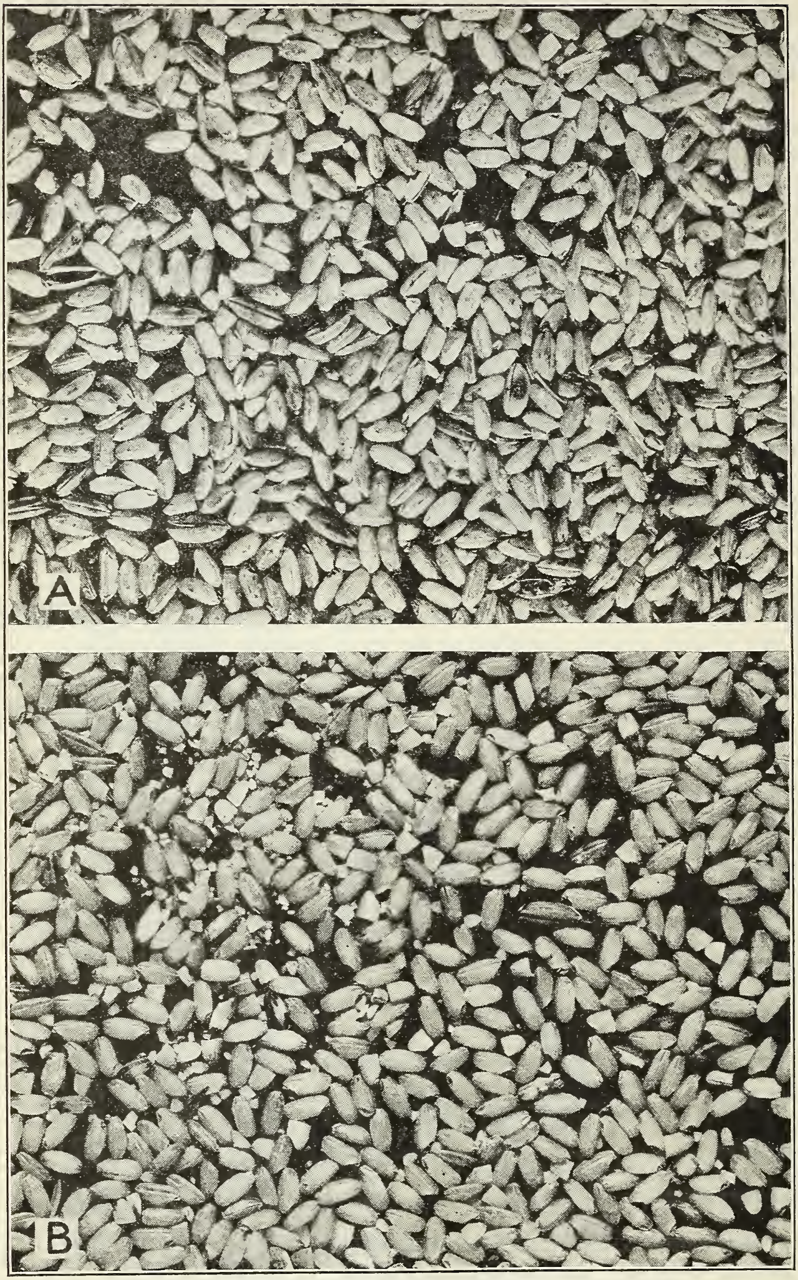

Fig. 4.—Shellings from the same lot of rice. A, Made by hand; B, made with the shelling device

That a good indication of milling quality can be obtained by the use of this shelling device was demonstrated during investigations conducted during the seasons of 1925–26, 1926–27, and 1927–28. During the season of 1926–27, 187 samples of rough rice of the Blue Rose variety were tested with the device. After the shellings had been made and the percentages of whole kernels in the shellings ascertained, the results were put into tabulated form. The relative hardness of these samples is shown in Table 2. In these tests the average percentage of whole kernels found in the shellings was 63.9 per cent. Approximately 5 per cent of the shellings of the samples showed only 50 per cent or less of whole kernels, 77 per cent of the shellings of the samples showed over 60 per cent of whole kernels, and 16 per cent of the shellings of the samples showed over 70 per cent of whole kernels. These tests indicate the wide range of quality with reference to the quantity of whole kernels that may be found in the shelling of any given lot of rice and illustrate the need for a definite and uniform method for ascertaining the percentage of whole kernels that can be obtained in milling from the various lots of rough rice that are offered for sale.

TABLE 2.—*Variation in percentages of whole kernels found in shellings of 187 samples of Blue Rose rough rice*

[Samples taken from rice crop of 1926–27]

Whole kernels obtained (per cent)	Samples	Percentage of total number of samples in each size group	Whole kernels obtained (per cent)	Samples	Percentage of total number of samples in each size group
	Number	*Per cent*		*Number*	*Per cent*
50 or less	10	5.4	60.1 to 62	15	8.0
50.1 to 52	3	1.6	62.1 to 64	19	10.2
52.1 to 54	4	2.1	64.1 to 66	26	13.9
54.1 to 56	9	4.8	66.1 to 68	28	15.0
56.1 to 58	8	4.3	68.1 to 70	26	13.9
58.1 to 60	9	4.8	70.1 and over	30	16.0

Average, all tests, 63.9.

SHELLING TESTS TO INDICATE MILL CONTROL

A shelling test made with this new device is also important in connection with mill-control work, for it suggests to the miller how any given lot of rice should be handled to give the best milling results, and it indicates what milling results should be obtained from each lot of rice that is so tested.

RELATION OF SHELLING RESULTS TO MOISTURE CONTENT

A further use for the shelling device has been developed through studies of moisture content of rice. The rough rice marketed during some seasons has a high moisture content because of climatic conditions and other factors. Tests made with the shelling device on rice before and after natural drying, and tests made before and after commercial drying, when the commercial drying was efficiently performed, show that when the excess moisture is removed from the rice

the kernels become harder and a higher percentage of whole kernels will be obtained in milling.

A sample of rough rice which contained 16.6 per cent moisture was tested with the shelling device, and 48.1 per cent of whole kernels was found in the shelling. The sample was put into an open pan, which was placed on a shelf in an office and permitted to dry at room temperature for six days. During this period the moisture content was reduced through natural drying to 10.9 per cent, and on the sixth day a rubbing test with a shelling device showed 63.5 per cent of whole kernels, which was a decrease of 5.7 per cent in moisture content and an increase of 15.4 per cent in whole kernels. The results of the test are shown in Table 3.

Similar results were obtained in a commercial mill when rice was tested that had been efficiently dried in a commercial drier. A shelling test showed that a lot of rough rice which contained 19.4 per cent moisture contained 32 per cent of whole kernels. After the rice was dried to 15.4 per cent moisture the shelling test showed 43.8 per cent of whole kernels. In this experiment the moisture content was reduced by 4 per cent, and the shelling test showed an increase of 11.8 per cent of whole kernels after drying.

TABLE 3.—*Hardening effect of natural loss of moisture in rough rice*

Time at which sample was tested	Moisture content	Shelling-device results		
		Whole kernels	Broken kernels	Total rice [1]
	Per cent	*Per cent*	*Per cent*	*Per cent*
Before drying	16.6	48.1	18.5	66.6
Second day	15.6	52.3	17.6	69.9
Third day	13.9	59.1	12.4	71.5
Fourth day	12.7	60.0	12.4	72.4
Fifth day	11.8	62.1	10.9	73.0
Sixth day	10.9	63.5	10.7	74.2

[1] The difference between the total and 100 per cent represents the loss of hulls and other refuse.

A shelling test showed that another lot of rough rice which contained 16.3 per cent of moisture contained 58.1 per cent of whole kernels. After the rice was dried artificially in a commercial drier to 13.3 per cent moisture the shelling test showed that the rice contained 63.4 per cent of whole kernels. In this experiment the moisture content was reduced by 3 per cent, and the shelling test showed an increase of 5.3 per cent of whole kernels after drying.

These tests indicate that the shelling device provides a mechanical means, with the human element entirely removed, for making comparisons of the hardness of rice before and after it is dried. They also illustrate how the device can be used to determine the best time to mill any given lot of rough rice and suggest how the operation of commercial rice driers should be controlled to obtain the best results. An accurate shelling test also shows the miller, mill grader, and warehouseman, the defects that are in the rice and thus indicates what can be done to improve the quality of the rice through drying or handling to give best milling results.

USE OF THE SHELLING DEVICE

The shelling device described in this circular is now regularly used in connection with the inspection and grading of rough rice by two of the leading rough-rice inspection departments. The results of the tests obtained with the device are regularly used by two of the chief rough-rice growers' associations in connection with selling the rough rice for the members of that association. Other organizations which regularly use the device include several rice millers' laboratories, and a rough rice-conditioning and handling plant. The device is also regularly used in Government rice-testing laboratories.

The shelling device is recommended for use by millers, rough-rice buyers, and dealers, and by graders; by selling organizations, associations, and rice-inspection departments; and by any individual who needs to ascertain the milling quality and other quality factors of rough rice or who needs better and more uniform shellings than can be made by hand.

HOW TO MAKE A SHELLING WITH THE DEVICE

CORRECT SAMPLING ESSENTIAL

The portion of rough rice needed for making a shelling is 50 grams. It is essential for correct results that the 50-gram portion used for the test be truly representative of the lot from which it is drawn. It is recommended that a modified Boerner sampler be used for obtaining the portion from the original sample. (Fig. 5.) The entire original sample is put through the Boerner sampler and is thus split down until the required quantity is obtained.

HOW TO OPERATE THE SHELLING DEVICE

The 50-gram portion of rough rice to be shelled is placed in the center of the upper surface of the base of the shelling device. The kernels do not need to be scattered, as the first two or three strokes of the rubbing block will accomplish this. After the rice has been placed in the device the motor and mechanism are started by closing the electric switch on the automatic cut-off device. After the motor is started it will run until the rubbing block has made the required number of strokes across the rice, when it stops automatically. To remove the shelling from the device it is necessary only to release a catch, turn the device down over the end of the table to which it is hinged, and brush the contents into a pan which is fastened to the hopper. The position of the device and base when it is being emptied is shown in Figure 6.

SEPARATING LOOSE HULLS FROM RUBBED RICE KERNELS

To separate the loose hulls from the kernels in a shelling it is recommended that a Bates laboratory aspirator [2] be used. (Fig. 7.) It is practically impossible for a person to blow the loose hulls from a rubbed portion by lung power without losing some of the smaller particles of rice kernels, but with the Bates aspirator a clean separa-

[2] Developed by E. N. Bates, senior marketing specialist, Bureau of Agricultural Economics, and covered by public-service patent No. 1524012.

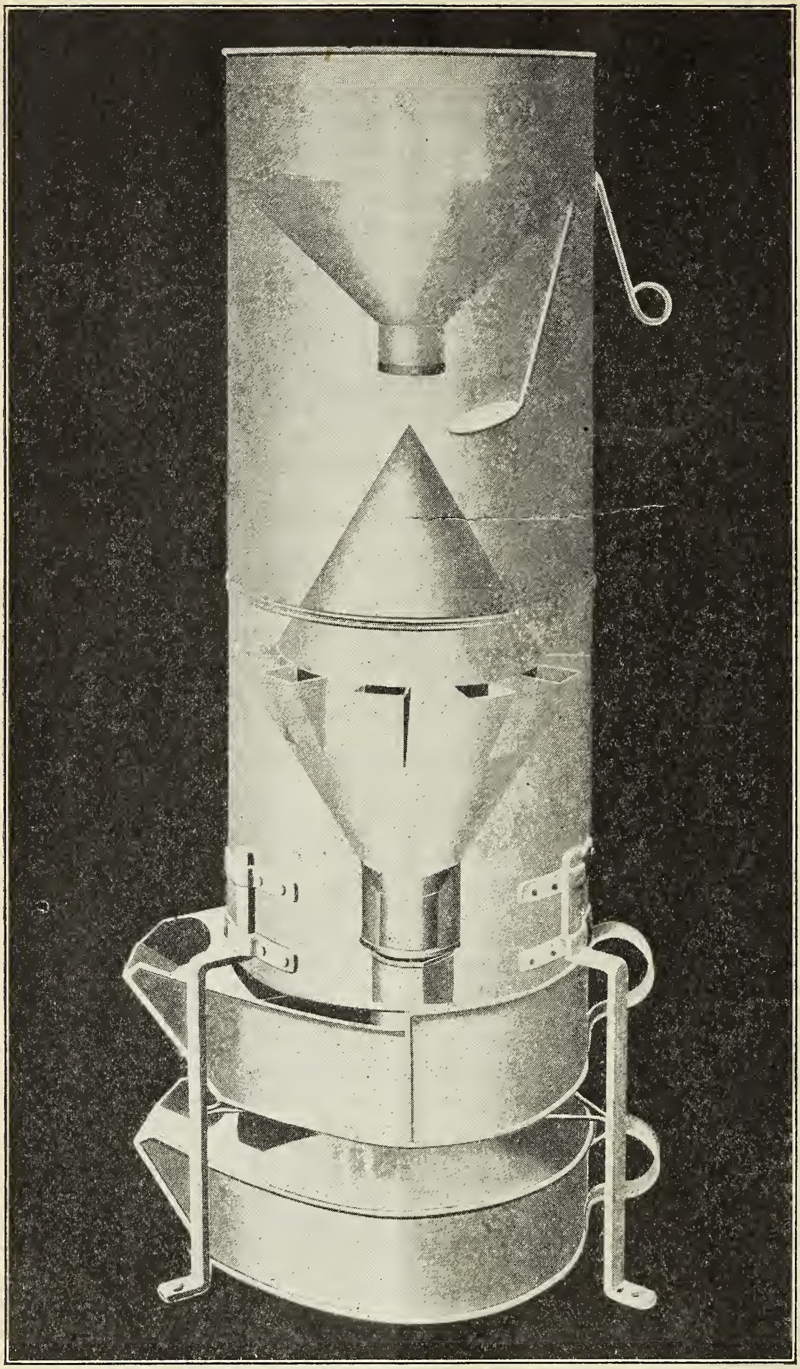

Fig. 5.—Phantom view of modified Boerner sampler

tion of hulls and rice kernels can be made. Separations of hulls and kernels made with the device are shown in Figure 8.

HOW SHELLING RESULTS ARE INTERPRETED

ASCERTAINING MILLING QUALITY

After the loose hulls have been removed from the shelling, the rice (including both whole and broken kernels) is weighed, and the total yield of rice is computed. The rice is then separated by means of sieves and by hand picking into four portions: Whole kernels, large-size broken kernels, medium-size broken kernels which will pass through a No. 6½ sieve but will not pass through a No. 5½ sieve, and finely broken kernels which will pass through a No. 5½ sieve.

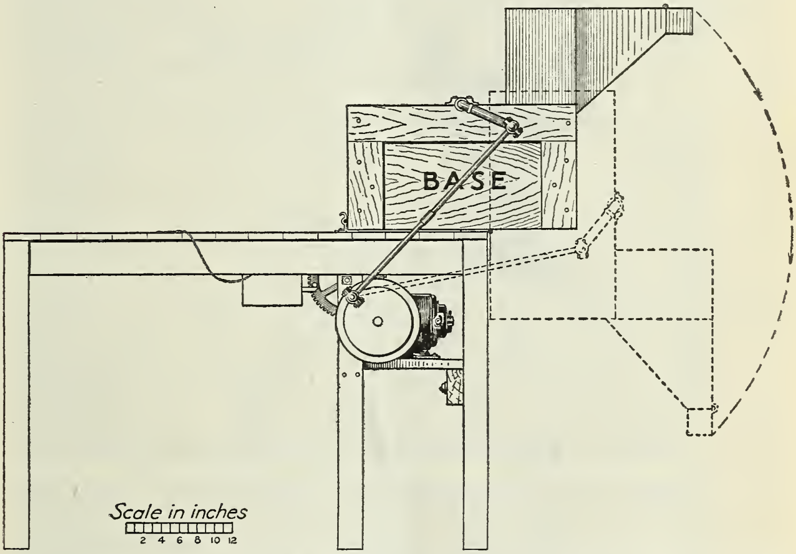

FIG. 6.—Position of base, disk, and drive rod when shelling is completed and (dotted lines) when contents are being emptied

In the sieving operation some of the whole kernels will often pass through the No. 6½ sieve along with the medium-size broken kernels. These whole kernels are picked out by hand and returned to the bulk of the whole kernels which remain on the No. 6½ sieve. Likewise large-size broken kernels will sometimes remain with the whole kernels on top of the No. 6½ sieve. These broken kernels are picked out by hand.

The percentage of whole kernels in a shelling indicates the probable yield of whole kernels or head rice when the lot of rice from which the sample was taken is milled. The yields of Second Head rice, Screenings, and Brewers rice are indicated by the percentages of the broken kernels of these three sizes that are present in the shelling. Because of the different results in milling obtained by different millers, the approximate relationship of shelling results to milling yields in any given mill can best be determined by the miller after using the device.

DETERMINATION OF PERCENTAGES OF RED RICE, DAMAGED KERNELS, AND CHALKY KERNELS

After the milling quality has been ascertained the shelling is used for the determination of the other factors which affect the quality values of the rough rice. Because the shelling device makes a complete shelling of practically all of the kernels in a portion of

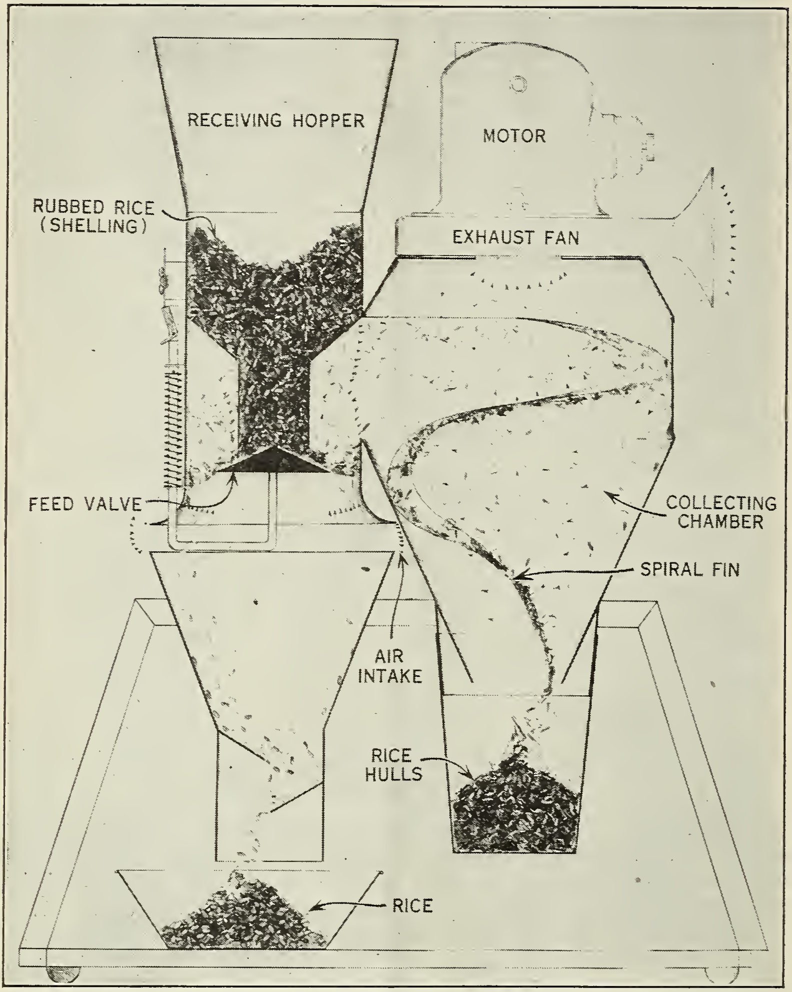

FIG. 7.—Bates laboratory aspirator. This device is used for separating the loose hulls from the rice kernels after the rice has been rubbed with a Smith shelling device

rough rice, accurate percentages of the red rice, damaged kernels, and chalky kernels present are more easily and quickly ascertained than is possible in the case of a hand shelling. On the basis of the weight of the shelling (minus the removed hulls), it is a simple matter to compute the percentage of red rice and other defects present. The grade of the lot of rough rice, a sample of which has

been shelled, can thus be established on a definite basis, and the price will be affected accordingly.

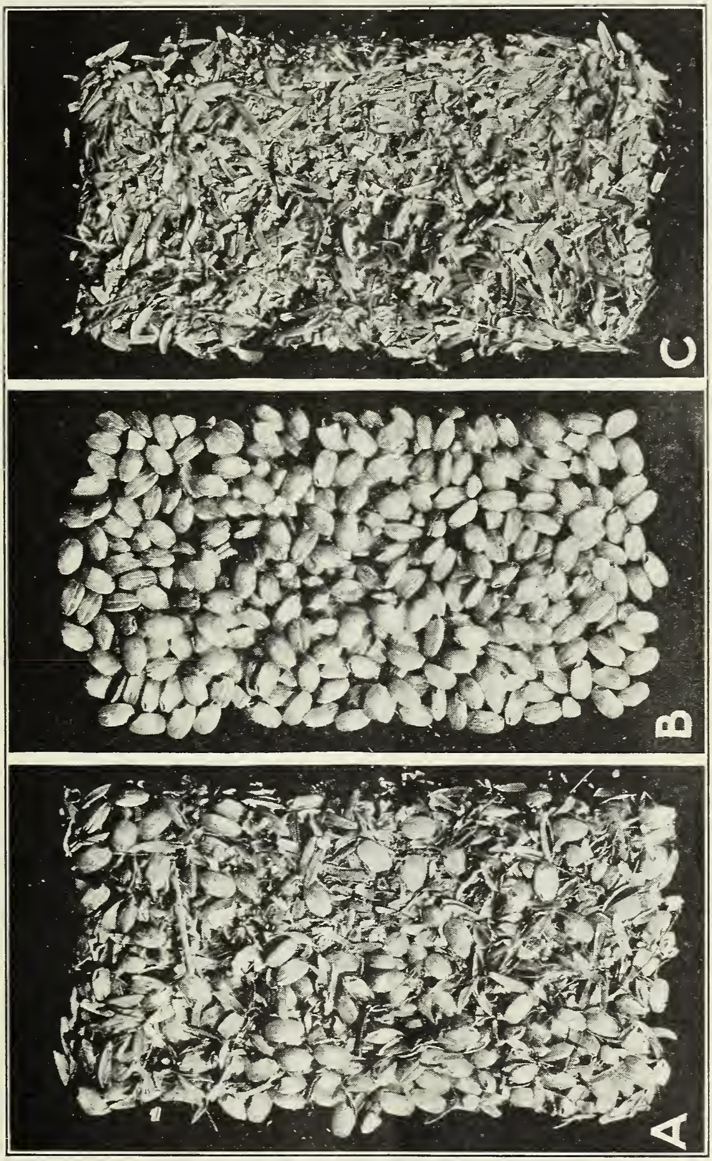

FIG. 8.—Separations made from shellings of rough rice: A, "Shelling" as removed from shelling device; B, kernels as separated by the Bates laboratory aspirator; C, hulls as separated by the aspirator

CONSTRUCTION OF THE DEVICE

The construction of the shelling device is comparatively simple. The following description of the parts and the drawings are given in order that any one interested may be able to construct the device. It can also be purchased on the market.

BASE

The base of the apparatus is constructed of 12 boards, each 28 inches long, 13½ inches wide, and 1½ inches thick. From each of these boards a semicircle is cut as shown in Figure 9. The 12 pieces are then assembled and are fastened together securely by pins, bolts, glue, or other suitable means, in the way shown in Figure 10. The outside dimensions of the base should be 28 by 13½ by 18 inches. The inside surface should be in the shape of a half circle 24 inches in diameter and 18 inches wide. Boards less than 1½ inches thick may be used in the construction of the base if a sufficient number are used to make the base of the proper dimensions.

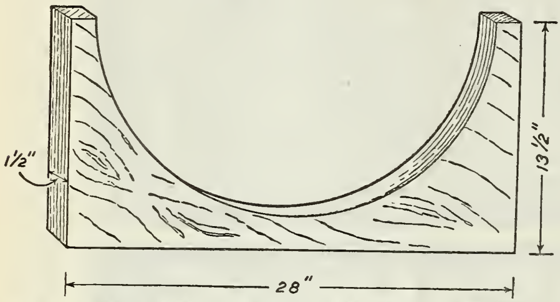

FIG. 9.—Size and shape of one of the boards of which the base is constructed

The sides for the base are made of 2 by 4 inch material and boards (f) 1 inch thick, constructed as shown in Figure 11. Screw holes are made in the sides at the points indicated, and wood screws 2½ and 3 inches long are used for fastening the sides to the base. Pillow blocks (g) are mounted on the top edge of each side for holding the shaft shown in Figure 12.

RUBBING BLOCK, SHAFT, AND ARMS

The rubbing block is made of wood and is in the form of a half round (a) 17¾ inches long and 3 inches across the top, (b) as shown in Figure 12. The lower curved surface is covered with two layers of hogskin leather. It is preferable to put on a thin piece of the leather first and then cover this with a thicker, tough piece. The leather (c′) is drawn tightly over the surface (c). The leather is held in place by means of flat-head wire nails designated as ⅝ by 18, driven along the top edges of the block. The block and leather do not have sufficient weight, and it is necessary to increase the weight to 15 pounds by placing sheet lead on the top surface of the rubbing block. The lead (b) is placed on the surface in the manner shown in Figure 12. It is essential that the weight of the lead be distributed evenly over the length of the surface of the rubbing block.

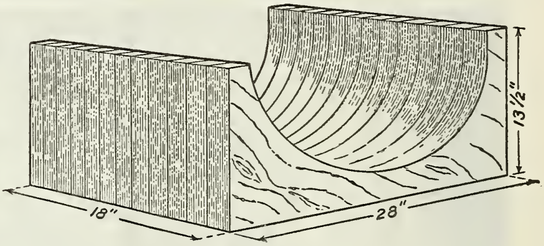

FIG. 10.—The 12 boards assembled to form the base

In Figure 13 the construction of the shaft and arms is shown. A piece of ¾-inch solid shafting (j), 22½ inches long, is threaded at one end for ¾-inch gas pipe. Two ¾-inch side outlet tees are then

driven on to the shaft (j). In each of the lower openings of the tees (k) two reductions, three-quarters of an inch to three-eighths of an inch, are placed and the arms (l) are screwed into these reductions. Each arm (l) is made with a piece of ⅜-inch gas pipe, 10¾ inches long, threaded one-half inch at one end and with a hole three-eighths of an inch in diameter near the opposite end. The center of the hole is seven-sixteenths of an inch from the end of the arm (l).

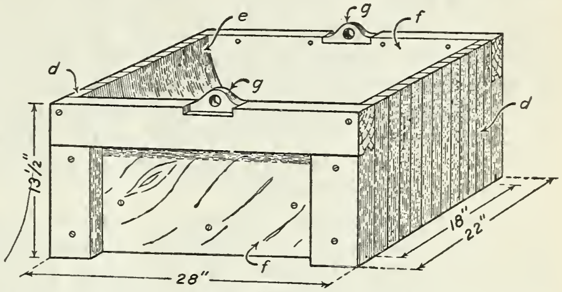

FIG. 11.—Base of the device, with the sides in place and the pillow blocks mounted

To adjust the arms (l) in the proper positions, the two arms on one side are placed parallel to each other. They are then fastened securely in place by passing pins through the tees (k) and the shaft (j).

The handle which connects the shaft and arms to the drive rod is shown in Figure 13. A ⅜-inch 90° elbow (n) is placed on the end of the shaft (j). A piece of ⅜-inch gas pipe (o), 4½ inches long, is threaded one-half inch at each end and is then put into the elbow (n). A tee (o′) is made of a reducing tee ¼ by ¼ by ⅜ inch, the length of which is reduced to 1⅛ inches by sawing off the ends with

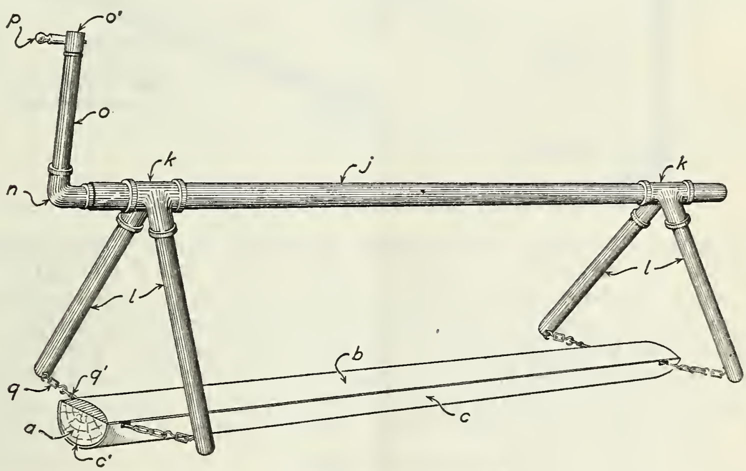

FIG. 12.—Construction of rubbing block, handle, shaft, and arms, and method of fastening the rubbing block to the arms

a hack saw. This tee (o′) is placed on the end of the 4-inch gas pipe (o). A steel rod (p), 2½ inches long, with threads on one end and made in the shape of a ball at the other end, is put through an opening in the shortened tee (o′) and held in place by a nut.

The rubbing block is fastened to the arms by means of turnbuckles (q) and links of chain (q′). (Fig. 12.) The chain should

be strong and flexible, but not too large. Two lengths of chain, each 8 inches long, are needed. A groove is cut across the top surface of the wood in the rubbing block under the lead near each end, and the lengths of chain are fastened in these grooves with screws so that approximately 2½ inches of chain extend out of the block on each side at each end. (See fig. 12.) One end of each turnbuckle (q) is fastened to the chain (q′) and the other end of the turnbuckle is fastened with a hook in the hole of the arm (l). After the rubbing block is fastened to the arms, and the shaft is passed through the pillow blocks, there should be just enough slack in the chains to allow the block to rest with full weight on the upper surface of the base. (Fig. 3.) If the slack in the chain is not right it can be adjusted by turning the turnbuckles.

Before the sides are fastened to the base the curved surface (e) of the base, as shown in Figure 11, is covered with one piece of hogskin leather, and the sides (f) are lined with galvanized iron. The hogskin leather is drawn tightly over the surface (e) and fastened by means of flat-head wire nails, designated as ⅝ by 18, driven 3

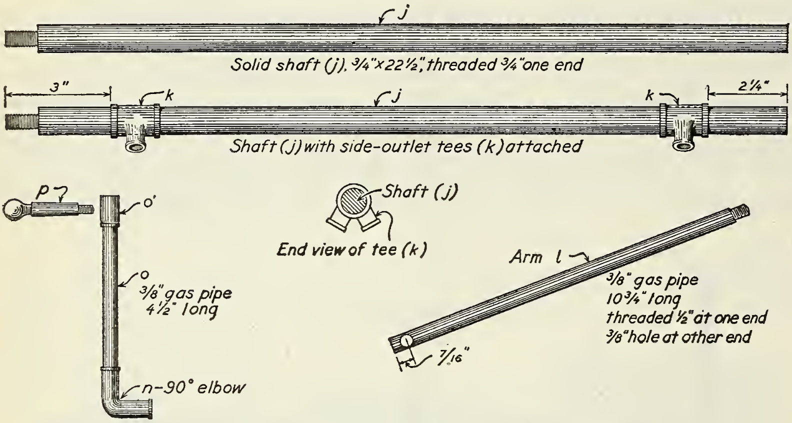

FIG. 13.—Construction of the shaft, arms, and handle

inches apart each way. The leather should be drawn down over the edges of the surface (e) about 1 inch, so that when the sides are fastened to the base there will be no crack between the sides and base. The galvanized iron on the sides is cut to fit the inside surfaces of the sides, and holes are made in the iron to fit the screw holes in the sides. When the sides are put in place the screws are passed through the sides, then through the holes in the galvanized iron, and into the base. It is best to use wood screws, designated as 2½ by 10, in the thin part of the sides and screws designated as 3 by 10 through the thick part of the sides.

After the sides have been fastened to the base, pillow blocks (g) should be placed so that the centers of the shaft holes in the pillow blocks are 14 inches from each end of the sides and in line with the tops of the sides. The pillow blocks should have shaft holes three-fourths inch in diameter.

HOPPER

The hopper, which is fastened to the base (shown in fig. 6), is made of light galvanized iron. The straight sides, which are fastened to

the base, measure 6½ inches wide and 13 inches long. The small end of the hopper should not project more than 12 inches from the base. A pan is made to fit over the outer end of the hopper, and an elbow catch is used for holding the pan on the hopper.

The hopper is fastened to the base between the galvanized-iron linings and the sides (f) of Figure 11. This may be done by taking out the top screws which hold the sides to the base and sliding the lower edges of the hopper down 3 inches between the sides and the galvanized-iron linings. The top screws on each side will then pass through the side of the base, the side of the hopper, the lining, and into the base. Additional small screws should be used to hold the hopper rigid.

MOUNTING THE DEVICE

A table or bench about 5 feet long and 2 feet wide and at least 32 inches high is needed on which to mount the shelling device. (See fig. 6.) The wheel or disk of the driving mechanism has a diameter of 10 inches. The wheel is placed on the end of a ¾-inch shaft, which should be at least 1 foot long. The center of the shaft should be 6 inches below the lower edge of the 2 by 4 forming a part of the top of the table and 11 inches from the inside of the table legs. In the wheel, 3¾ inches from center, a hole is drilled. Into this hole is fastened a pin which is threaded on one end and the other end of which is shaped like a ball. (See p in fig. 13.)

The base, with the hopper, shaft, arms, and rubbing block mounted on it, is next placed on the table so that 10½ inches of the base extends over the end of the table. The base is fastened to the table by means of a pair of 4-inch square hinges. The pin (p) on the end of the handle (o in fig. 12) is connected with the similar pin on the wheel (fig. 6) by a rod. The rod is of steel, with a socket at each end; into these sockets the pins (p) are fastened.

The device is driven by means of a motor of one-fourth horsepower, having a speed of 1,750 revolutions per minute. A single-thread steel worm is placed on the shaft of the motor with a ball-race thrust bearing between the worm and the motor housing. The steel worm is meshed with a bronze worm gear of 50 teeth, which gives a speed reduction of 50 to 1.

The base is held rigid on the table by means of a sash catch. (Fig. 6.)

After the device has been mounted and coupled with the motor it is necessary to adjust the stroke of the rubbing block on the surface of the base. The stroke should be the same length on each side of center, and after it has been adjusted the parts should be held securely in place by pins passing through the elbow (n) and shaft (j). (Fig. 12.)

AUTOMATIC CUT-OFF

The device is equipped with an automatic cut-off switch (fig. 14) which stops the action of the rubbing block after any given number of rubs for which the switch is set and makes certain that each sample will be rubbed a given number of times. In the center of the end of the shaft (w), on which the wheel or disk is mounted, a hole is bored and a pinion rod (w′) is inserted in this hole. The

pinion rod (w′) meshes with a spur gear (x). Into the spur gear (x) a round steel pin (x′) three-sixteenth inch in diameter and three-fourth inch long is inserted.

The cut-off switch[3] is used for breaking the electric circuit when any given number of rubs for which the switch is set have been completed. The switch is shown with all parts in position with the circuit open. By pulling the cord the knife is released and pulled into contact with the switch terminals, the device is set in motion, and the pin (x′) of the spur gear (x) moves around and engages the arm of the cut-off switch.

As the spur gear (x) continues to move, the pin (x′) and the arm reach a point where they are disengaged, and the arm snaps back to the position shown in the drawing. As the arm goes back to this position, it pulls the knife across and breaks the electric circuit.

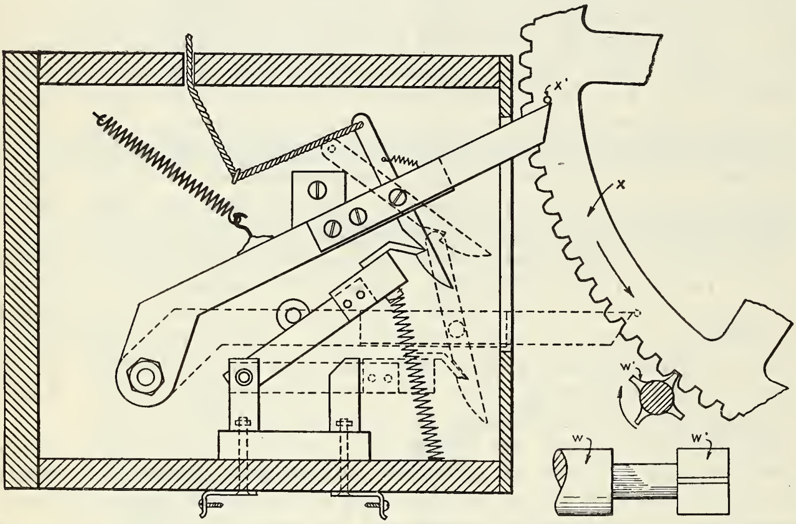

FIG. 14.—Automatic cut-off device, showing pinion rod in end of shaft, gear meshing with pinion rod, and the switch mechanism

The automatic cut-off should be adjusted so that the electric current is broken when the wheel and rod are in the position shown in Figure 6.

CONCLUSION

Mechanical tests are always less likely to vary than tests made by hand so it is desirable that tests which are made to ascertain the qualities of lots of rough rice be made, if possible, with the human element removed. This will insure accurate, fair, and impartial results. The shelling device makes it possible to apply a standard, unvarying test to determine hardness or milling quality of rough rice, and a test of this kind makes it possible to grade rough rice for the factor of milling quality in a more satisfactory way than has heretofore been possible.

[3] A public-service patent (No. 1641647) covering the switch has been granted to the author, who devised it.

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